Effects of the "One Belt One Road" initiative on the wine import logistics of China

Abstract

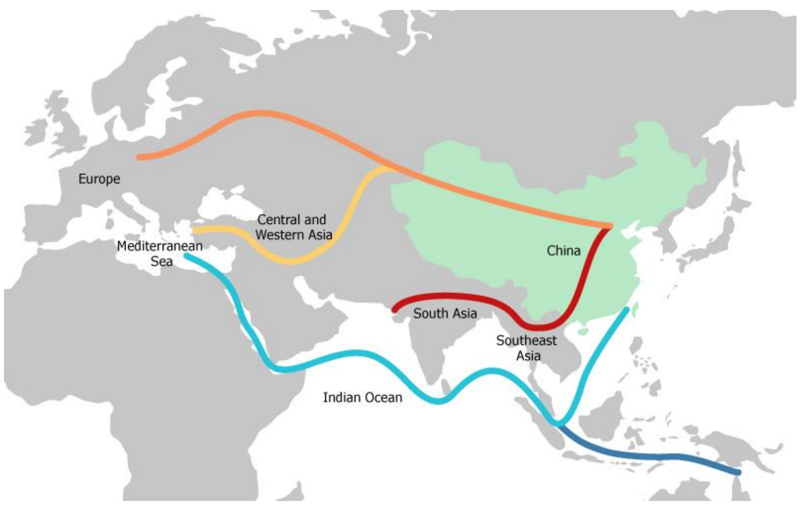
The One Belt One Road (OBOR) initiative is expected to facilitate international trade between the countries involved. Meanwhile, the growth of wine imports helps China to balance its trade with other countries, especially the wine producers in Europe. This improves the attractiveness of the OBOR initiative to international stakeholders and provides the maritime sector with an excellent growth opportunity. The trade and logistics operations of the wine industry involve some special requirements and many value-added services. Therefore, it is often economical for wine importers to consolidate their logistical services in one city to achieve economies of scale for logistics and other trade-related activities. In this study, we review the special requirements of wine logistics and the market growth potential of wine consumption in China. A model minimizing generalized logistical costs is developed and applied to wine imports in China, so that the best candidate cities in which to locate transport gateways and distribution centers can be identified. Our analysis suggests that the most preferred gateways are Shanghai, Tianjin, Guangzhou, and Hong Kong, which have similar delivery costs. In comparison, Beijing and Chongqing have much higher delivery costs, mainly because they do not have good access to marine transport and/or efficient domestic distribution networks. For long-distance inter-continental transport, marine shipping remains the only viable delivery mode for large-volume wine trade. However, wine distribution within China extensively uses air, road, and water transport. Therefore, cities with excellent multi-modal transport services are better positioned to become wine logistics gateways. Our study also highlights the importance of value-added services and good government support, which are important factors influencing distribution costs and quality.

Key words: Wine logistics; Mainland China; One Belt, One Road; Maritime Transport Routes

1. The One Belt One Road initiative and implications for Chinese wine import logistics

The One Belt One Road (OBOR) initiative is marketed by the Chinese government as the "twenty-first century maritime Silk Road and the Silk Road economic belt." The initiative encourages policy coordination, trade facilitation, financial integration, and transport connectivity. A regional economic cooperation framework is expected to be formulated and developed in the coming years. From November 26, 2013, 30 OBOR-related plans for implementation and cooperation agreements can be seen in the agendas of major international meetings. A typical example is the Chinese National Development and Reform Commission's (hereafter the "NDRC") declaration of its *Vision and Actions on Jointly Building the Silk Road Economic Belt and Twenty-first Century Maritime Silk Road* of March 28, 2015. Since then, the framework, key areas of cooperation, and cooperation mechanisms related to the OBOR initiative have become much clearer (HKTDC, 2016). The OBOR initiative covers at least 65 countries across Asia, Africa, Middle East, and Europe. It involves six international economic cooperation corridors (i.e., the New Eurasia Land Bridge Economic Corridor, China-Mongolia-Russia Economic Corridor, China-Central Asia-West Asia Economic Corridor, China-Indochina Peninsula Economic Corridor, China-Pakistan Economic Corridor, and Bangladesh-China-India-Myanmar Economic Corridor) covering the major cities and transport routes under the OBOR (Figure 1) (HKTDC, 2016).

Figure 1: One Belt, One Road Geographical Map



Source: HKTDC, 2016

The OBOR initiative aims to promote trade and economic cooperation along the Asia-Middle East-Europe region, where the commodity trade has experienced substantial growth since China's "open-door" policy was enacted in the early 1980s. However, commodity trades between Europe and Asia are quite imbalanced, with more cargo being exported from Asia to Europe than the other way around. Such an imbalance not only leads to asymmetric cargo flow and underuse of backhaul transport, but also creates political concerns and trade disputes with major Asian countries, especially China, which is the world's No. 1 exporter. To make the OBOR initiative attractive to the other countries involved, China needs to facilitate or even promote imports from these countries, especially commodities it cannot produce or for which Chinese consumers have a strong preference. One promising product category is wine and other alcoholic drinks.

The Chinese have produced and consumed rice wine regularly since 1500 B.C.E. However, grapevines are not native to China, and their introduction into the Far East along with wine products reached China no earlier than the second century. As vine growing was largely limited to the western region (currently Xinjiang and the countries near the OBOR region), the technologies of wine production were not seriously studied or widely circulated among the Chinese. The golden age of Chinese wine before the modern era comprised the twelfth and thirteenth centuries under Mongolian rule. The Mongols created a great empire spreading across the Eurasian continent so that passage between the Far East and Europe was rather safe. Merchants such as Marco Polo arrived in China with their finest merchandise, including fine wine. The ruling house of the succeeding Ming dynasty (1368-1644), however, had no interest in wine and imposed a general prohibition on alcohol, causing wine production to almost disappear (Zhou, 2016). The rice wine culture revived again in the later Ming dynasty, but wine never regained its former glory until interactions with the major European powers intensified in the mid-nineteenth century. At that time, wine from France and other European countries was imported to different parts of China as an exotic drink. Vines were soon planted in selected regions with suitable climates, notably in Shanxi, Shangdong, Guizhou, and Yuannan. Since then, the Sino-Japanese War (1937-45), Chinese Civil War (1945-49), and the pre-1979 political movements of the People's Republic of China (PRC) might have hindered the further growth of China's wine industry. Nevertheless, in the contemporary era, when Chinese citizens are becoming more adapted to the lifestyles of the West, wine is once again gradually becoming a "rising star" in the Chinese consumer market.

According to international wine and spirit research, in 2012, China's wine consumption reached 210 million bottles (i.e., 1.31 liters per person). Wine consumption is mostly concentrated in the major cities, such as Beijing and Shanghai (Trade and Industry Department, 2013). We summarize China's wine city development index and China's wine city potential index in Tables 1 and 2, respectively.

Table 1 China Wine City Development Index

Ranking	City
1	Shanghai
2	Beijing
3	Wenzhou
4	Chengdu
5	Hangzhou
6	Taiyuan
7	Qindao
8	Dalian
9	Wuhan
10	Shenyang

Source: Lau et al. (2015)

Table 2 China Wine City Potential Index

Ranking	City
1	Wuhan
2	Taiyuan
3	Zhengzhou
4	Dalian
5	Chengdu
6	Chongqing
7	Tianjin
8	Jinan
9	Harbin
10	Ningbo

Source: Lau et al. (2015)

In terms of vineyard area, China is ranked second in the world (about 810,000 hectares) (Lau et al., 2015). It has been forecasted that China's wine consumption will be ranked first in the world in 2020. However, China's wine market is experiencing fierce competition between domestic (e.g., company/brands such as *Great Wall*, *Dynasty*, *Changyu*) and foreign brands, notably those from France, Australia, and Chile. The volume and market shares of the top 10 wine exporters to China are summarized in Table 3. As a rather heavy import tax (14%) is currently imposed on foreign-imported brands, the selling price of foreign brand wine is, in general, significantly higher than that of domestic wine. Currently, the ratio of domestic brand wine to foreign brand wine is three to one (Trade and Industry Department, 2013). Overall, wine consumption in China is quite stable, achieving sustained growth over many years.

Table 3 Top 10 Wine Exporters to China in 2015

Ranking	Country	Liter	Value (USD)	Market Share (%)
1	France	166,279,191	863,292,661	47.6
2	Australia	56,642,300	439,376,537	24.2
3	Chile	48,749,105	170,015,879	9.4
4	Spain	54,436,787	112,188,945	6.2
5	Italy	22,592,255	82,112,459	4.5
6	USA	9,989,231	51,554,380	2.8
7	South Africa	9,221,072	38,608,268	2.1
8	Argentina	4,981,471	19,975,346	1.1
9	New Zealand	1,846,625	18,710,850	1.0
10	Germany	3,801,531	17,078,063	0.9

Source: www.winesinfo.com (2016)

Unlike most manufactured goods, the trade and logistics operations of wine involve some special requirements. For example, although rail is a fast and economical transport mode with a good balance between speed and cost, it is rarely used for wine because rail vibration damages its quality.[1] In addition, drink and food imports into China often involve a significant amount of documentation and relabeling, and in most months of the year the storage and transport of wines also needs to be performed in a temperature-controlled environment. This involves an investment in dedicated facilities. As a result, it is often economical for wine importers to consolidate their logistical services in one city to achieve economies of scale for logistics and trade-related activities. Considering the sustained growth of Chinese wine imports, logistics firms need to engage in long-term planning to build such networks. However, although numerous studies discuss the supply chain configuration of manufactured goods in general, few investigate the logistics operations of specialized cargo such as wine.

This study aims to contribute to the literature in several ways. First, the maritime industry is currently facing tremendous challenges due to an oversupply of capacity, whereas growth in the worldwide commodity trade is sluggish. The industry needs to identify growth opportunities and provide more value-added services. With the majority of international wine trade carried by sea, the proposed OBOR initiative provides a good opportunity to promote it among the countries involved, especially those located between Europe and China. This study provides a timely analysis for the maritime industry. Second, as discussed in the following sections, many studies use complex models to choose the best location for shipping gateways and distribution centers. Such models provide very detailed information, but they are nevertheless sensitive to the parameter values associated with key assumptions. In the other extreme, studies in the geography discipline also analyze the economic effects of ports/airports strategic locations. However, such

[1] Rail is used for beer, which is less prone to such damage.

studies usually focus on one transport mode (e.g., maritime) and general cargoes. As a result, they do not offer direct findings related to the comprehensive shipping network configuration of one particular product such as wine. In this study, we plan to adopt a middle approach: although we incorporate both the shipping and time costs related to maritime and air cargo services within a cost-minimization shipping network design model, we mainly focus on the effects of geographic location/distance on the location choice of shipping gateways and distribution centers. Such an approach allows us to develop long-term solutions with minimal assumptions.

The follow section briefly reviews the requirements of wine logistics and the implications for the Chinese market. Section 3 introduces the cost-minimization model and applies it to wine imports in China. Section 4 summarizes and concludes this study.

2. Wine logistics management and location choices of wine distribution centers

Wine logistics are fundamentally changing from self-managed to contracted-out arrangements. Excellent wine logistics service providers enable wine traders to reduce operating costs, fulfill demand fluctuations and improve returns on investment (Lun et al., 2006). Lau et al. (2014) discuss the evolution of wine logistics service providers, especially for information system management, transportation management, inventory management, and warehousing. With information system management, wine logistics service providers integrate information systems with various wine logistics activities to, among other things, verify the authenticity of wine and intercept suspected counterfeit wine. In wine logistics, EPC barcodes or radio frequency identification (RFID) (i.e., used for real-time inventory management and security in the wine warehouse) and anti-counterfeiting technology (e.g., smart phones application security labels with bar codes or QR code use) are commonly used. In transport management, wine logistics service providers deliver wine by road and sea transport at a low transportation cost and many bonded warehouses are established around the ports. To keep wine in good condition, wine logistics service providers either store wine bottles inside wooden crates or wrap air cushion around them for protection. In addition, they add insulation layers to the wine bottles to control temperature fluctuations. In inventory management, wine logistics service providers not only manage inventories from different suppliers in different regions, but also meet different customer demands from diverse channels across continents, such as retail shops, supermarkets, wholesalers, hotels, restaurants, and individual customers. Common technologies such as materials requirement planning (MRPII), electronic data interchange (EDI), customer relationship management (CRM), enterprise resource planning (ERP), and e-commence are used to support order management systems and coordinate wine demand with supply. Maintaining the thermostat and a suitable temperature are also important aspects of wine warehouse management. In Hong Kong, wine logistics service providers are required to install wine storage management storage (WSMS) under the direction of the Hong Kong Quality Assurance Agency (HKQAA).

Wine storage facilities must comply with the HKQAA's code practices and system requirements pertaining to humidity, temperature, vibration, LED lights, security, inventory management, fire systems, maintenance, hygiene, and insurance. In general, commercial wine and fine wine have separate storage requirements (Table 4). However, both must pay attention to variations in temperature when the wine is in transit.

Table 4: Commercial Wine and Fine Wine Storage

Items	Commercial Wine	Fine Wine
Maximum temperature variation per year	10^{o}C	5^{o}C
Maximum temperature variation per day	5^{o}C	3^{o}C
Temperature range	17-22^{o}	11-17^{o}C
Humidity	>50%	55-80%

Source: HKQAA (2013)

Due to the special requirements of wine logistics, wine imports into China call for both long-term planning and major investment. Many cities in the greater China region, including Hong Kong, are trying to attract more wine distribution business. It is undoubtedly true that OBOR provides a strong foundation for further development of the wine industry in China. Regional cooperation and competitiveness will be significantly enhanced (HKTDC, 2016). The Department of Trade and Industry (UK) identifies competitiveness as "the ability to produce the right goods and services of the right quality, at the right price, and at the right time" (source: http://www.dft.gov.uk). In discussing regional competitiveness, Porter (2003) notes how the industry counters competition from neighboring rivals by establishing innovative environments with skilled and creative workers, technological advancements and foreign investment. He further points out that scholars are increasingly incorporating the concept of industrial clustering into regional and national economies. For example, Porter writes that "clusters act as a geographical proximate group of interconnected companies, suppliers, service providers and associated institutions in a particular field." Clusters highlight the importance of reducing the intensity of competition, while simultaneously encouraging coordination and mutual improvement (Porter, 2000). Lau (2009) explains that cluster analysis is a classification tool used to help the industry characterize different groups of related and supporting industries. In the wine industry, we can identify various dynamic cluster boundaries within China's wine industry.

- 1st party users: own the wine commodities and deliver like global traders to small and medium-sized enterprises (SMEs).
- 2nd party users: own the logistics facilities or vehicles that provide the wine supply chain with services like terminal, warehouse, and transport operation.
- 3rd party users: offer tailor-made wine services to shippers and consignees, notably third

party logistics providers and freight forwarders.

- 4th party users: trade associations and governments that implement the international wine trade and regulations to fulfill customer demand and align with international wine standards.
- 5th Fifth party users: academic institutions and research centers that provide wine consultation services and research to increase the regional competitiveness of the Hong Kong wine industry.

With many stakeholders eyeing the growing wine distribution market in China, large investments are being made in both first- and second-tier cities in the coastal to inland regions. In the coming years, China is destined to become one of the world's major wine distribution and trading areas. Due to the complexity and multiple stakeholders involved with wine logistics and distribution, consolidating related activities at one location or building a centralized distribution center is economical. However, such plans often involve substantial investment over extended periods. Many factors must be considered in choosing the location of distribution centers, including the availability of convenient transport services, the market development of logistics service providers, the quality of government services such as customs clearance and trade regulations and the market size of local wine consumption. It is almost impossible to fully incorporate all of these factors into one analysis. Nevertheless, when the purpose is long-term planning, it is possible to use a simplified model to focus on some key elements that are stable over time. Thus, we use a cost-minimization model primarily based on geographic location and distance to identify promising cities in which wine logistics providers can locate their distribution centers and transport gateways.

3. A geography-based model of shipping routes and transit hub choices

3.1. The specification of the model

Transport and logistics network design is a well-established field, with many alternative objectives specified for optimal network configurations within the maritime sector. Frequently adopted objectives include, without limitation, minimizing costs, shipping time and emissions, and maximizing profits and/or revenue. (For a review, see Tran and Haasis, 2013. For exemplary studies, see, e.g., Sinha-Ray et al., 2003; Tavasszy et al., 2011; Halim et al., 2012). In the aviation industry, network design models are extended to incorporate inter-firm competition so that the optimal network choice may also reflect the competition between airlines (see, e.g., Hansen, 1990; Hong and Harker, 1992; Adler, 2001, 2005; Li et al., 2010; Adler, 2014). With detailed specifications regarding origin-destination (OD) traffic demands and the cost functions for each carrier (firm), it is possible to consider a wide range of scenarios with very sophisticated models. Although these models can be used to provide detailed results at the route and company levels, their complex specifications also come with some "side effects": as too many factors are incorporated, the modeling results may be sensitive to changes in the assumptions, value of certain parameters, and inter-firm competition scenarios considered. Although sensitivity analysis may be carried out on selected variables, it is often difficult to validate a large number of combinations of parameter values. As a result, although it is possible to develop a comprehensive model in our analysis, the results obtained may not be very accurate for identifying long-term patterns.

Another challenge in applying a complex network design model to this study is that many such models consider the full cost of a network, sometimes even using different parameters for each rival carrier. In reality, however, wine shipping volumes are likely to constitute a relatively small portion of the total merchandise traded in the markets we want to study. In addition, whereas the transport markets are very dynamic in terms of their technology (e.g., the types/sizes of ships), operational costs (e.g., the cost of fuel, port fees due, loading/unloading, transshipments), and market structure (i.e., competition and alliances), we are interested in analyzing the long-term pattern, which should not be excessively dependent on particular assumptions. Therefore, we focus the effects of geographic location and government services (e.g., customs clearance duration), which are either long term or can be controlled by public policy. For these considerations, we choose to develop a simple model that mainly captures the effects from the candidate ports and cities' geographic location. Although rail transport is one core shipping mode in China's OBOR initiative, it is not commonly used for wine due to the potential for vibration that damages the wine's quality and security related issues. Therefore, we restrict to marine and air shipping in our analysis.

In consideration of the preceding discussion, a geography-based shipping network model is developed with the aim to minimize the generalized shipping costs of wine imports to China. We plan to focus on the effects of (a) geographic location, (b) the time needed for customs clearance, and (c) the choice of transport mode. As both transport costs and (inventory) time costs are included, the generalized cost G is specified as

$$G = \left[\sum_{l \in r} c_l^m + \alpha_{vot}^m \left(t_p^m + \sum_{l \in r} t_l^m\right)\right] Q \tag{1}$$

where l denotes a transport link; r denotes a route consisting of a set of links from the point of origin to destination; m denotes transport modes that include aviation, sea, and road (denoted as a, s, b, respectively). The key parameters in the objective function are listed as follows.

- c_l^m : the transportation cost for shipping mode m on link l.
- α_{vot}^m : the value of time for shipping mode m.
- t_l^m : the transport time for mode m on link l.
- t_p^m : the customs clearance time for mode m at the port/airport in the Chinese city p.
- Q : the volume of wine to be shipped between the point of origin and the destination, measured in tons.

Both import and export cargoes must go through inspection and/or customs clearances. The time needed varies greatly across the different countries and ports involved. As we are the most interested in wines shipped to China, we consider only the time spent in Chinese cities, including Hong Kong.[2] As indicated in Eq. (1), the generalized cost for each unit (ton) of wine consists of

[2] Large volumes of wine are shipped to Hong Kong by air or sea, then delivered by truck across the border to Shenzhen. Therefore, the custom clearance time in Hong Kong is also included in our study.

the total time cost for customs clearance and transportation $\alpha_{vot}^{m}(t_p^m + \sum_{l\in r} t_l^m)$, and the monetary costs incurred for transportation from the point of origin to the destination $\sum_{l\in r} c_l^m$.

We now specify the calculation for transportation and time costs as follows. For air cargo operational costs, Swan and Adler (2006) estimate aircraft operational costs using actual industry data. Such a specification is subsequently used by a number of studies, such as Adler and Smilowitz (2007), Li et al. (2010), and Shen et al. (2015). Although Swan and Adler (2006) provide separate specifications for the wide and narrow body aircraft used for long (e.g., inter-continental services) and short distances (e.g., intra-continental/domestic services), they consider passenger services. Therefore, one passenger is converted to 85 kg in the specification.[3] In addition, airline efficiency studies such as those of Oum et al. (2005) and Wang et al. (2014) conclude that airlines carrying more cargo have significantly higher efficiency and lower costs. Accordingly, the unit cost for a wide-body aircraft serving the international market with a flying distance D_l^a is specified as

$$c_l^a = (D_l^a + 2200)(300 + 211) \cdot 0.0115 \cdot 65\%/(0.085 \cdot 300) \tag{2}$$

and the unit cost of a narrow-body aircraft serving the domestic market is specified as

$$c_l^a = (D_l^a + 722)(170 + 104) \cdot 0.019 \cdot 65\%/(0.085 \cdot 170) \tag{3}$$

A large number of studies analyze the cost of container shipping in the maritime sector. The largest part of a voyage's cost is often for fuel. Therefore, studies such as Psaraftis et al. (2009), Corbett et al. (2009), and Wang et al. (2015) use fuel cost to approximate the voyage cost with a cubic function of a ship's speed, energy efficiency and fuel price. Such a specification is useful in models that aim to analyze the optimal shipping speed, but it does not offer more insight when the objective is simply to estimate the market level shipping cost over the long term. Therefore, we consider the shipping costs as

$$c_l^s = t_l^s \cdot 100 \cdot f/(15000 \cdot 10) \tag{4}$$

where f is the bunker fuel price, which is set as US$255 per ton according to the price for IFO380 fuel oil in the middle of 2016 (BunkerIndex, 2016). We assume that a container ship can carry 15,000 TEUs, with the average weight per container being 10 tons (Leonardi and Browne, 2010). Daily fuel consumption is set at 100 tons. t_l^s can be obtained with a shipping distance D_l^s and an assumed ship speed, set to 20 knots in the base case. For trucking services, the national average cost per ton-kilometer is reportedly RMB0.53, which is approximately 10 cents in U.S. dollars.[4] Therefore we have $c_l^b = 0.1D_l^b$.

To calculate the time/inventory costs involved, Tavasszy et al. (2011) suggest that the value of time is US$100 per TEU per day. If this also applies to the wine industry, based on the assumed

[3] Airlines in China and some aircraft manufacturer (e.g. Airbus) use 85 kg to estimate the weight per passenger including luggage in flight planning.
[4] See, for example, a report available at the website of the Ministry of Transport in China http://www.moc.gov.cn/jiaotongyaowen/201601/t20160112_1974539.html

weight per container, it translates to US$10/ton each day; thus, $\alpha_{vot}^{s} = 10$. As air cargo tends to carry fine wine, whereas trucking services are usually used for domestic deliveries to retailers, it is assumed that $\alpha_{vot}^{a} = 50$ and $\alpha_{vot}^{b} = 5$. To calculate transportation time, it is further assumed that the average speed for air delivery is 740 km/h, and the average speed for trucking service is 80 km/h. The time needed for customs clearance is assumed to be one day for air cargo and five days for marine shipping.

Using the preceding specification, it is straightforward to minimize the generalized costs by comparing them along all possible routes and mode combinations for wine imports into China. Despite our efforts to consider only the long-term factors that are primarily dependent on the geographic location of a wine's country of origin, our specifications are subject to the influence of a number of assumptions that are not easy to validate. For example, the customs clearance time can vary greatly across countries and cities. Hong Kong provides excellent government services and comprehensive logistics operations. Customs clearance for air cargo and container shipping usually takes a few hours or two to three days, respectively. In comparison, the same process takes much longer in most cities in mainland China, with mega Chinese cities such as Shanghai and Guangzhou ranking somewhere in between. However, we are not aware of any official statistics summarizing customs clearance times. To remove the potential influence of subjective judgment, in our model, we assume the same values for all cities first, after which sensitivity tests are carried out to check the robustness of our models.

3.2. The application of the model and data sources

As with any network design analysis, an origin-destination (OD) matrix must be constructed. We first select a major port for each of the top 10 wine importing countries listed in Table 3 and report on them in the following Table 5. These ports are treated as the "origin" of wine imports to China.

Table 5. Leading Origin Ports for Chinese Wine Imports

France	Marseille (MRS)
Australia	Sydney (SYD)
Chile	San Diego (SCL)
Spain	Barcelona (BCN)
Italy	Genoa (GOA)
U.S.A.	New York (NYC)
South Africa	Cape Town (CPT)
Argentina	Buenos Aires (BUE)
New Zealand	Auckland (AKL)
Germany	Hamburg (HAM)

Based on interviews with about 20 wine distributors in Hong Kong, Lau et al. (2015) identifies 16 Chinese cities with a high wine development status or potential. These cities are identified as "destination" cities and include Shanghai, Beijing, Wenzhou, Chengdu, Hangzhou, Taiyuan, Qingdao, Dalian, Wuhan, Shenyang Zhengzhou, Tianjin, Jinan, Harbin, Ningbo, and Guangzhou. For wine distribution within China, we consider the cities where imports first arrive to be gateways, after which the wine is either consumed locally or redistributed to other destinations. The following destination cities are identified as potential gateways in our analysis, and are either major trading cities or mega metropolitan areas within China. They include Hong Kong, Beijing, Shanghai, Tianjin, Guangzhou, Chengdu and Chongqing. The travel distances between the points of origin and the destinations are compiled for each transport mode, respectively.[5]

Although China's aggregate wine import data are available, the detailed volume data for each city are unavailable to us. Therefore, following the principle of gravity models, we use the population and income at each destination city as a weight to allocate the total import to these cities. The 2014 income and population data are compiled from the National Bureau of Statistics of China and are summarized in Table 6.

Table 6. Characteristics of Selected Destination Cities

Destination	Population (10,000)	Per capita income (RMB)	Total income	Proportion
Shanghai	1,438.69	100,623	144,765,303.9	15.56%
Beijing	1,333.4	103,400	137,873,560	14.82%
Wenzhou	813.69	40,510	32,962,581.9	3.54%
Chengdu	1,210.74	63,201	76,519,978.74	8.22%
Hangzhou	715.76	70,823	50,692,270.48	5.45%
Taiyuan	369.74	57,771	21,360,249.54	2.30%
Qindao	780.64	62,097	48,475,402.08	5.21%
Dalian	594.29	63,609	37,802,192.61	4.06%
Wuhan	827.31	60,624	50,154,841.44	5.39%
Shenyang	730.84	56,590	41,358,235.6	4.44%
Zhengzhou	937.8	49,756	46,661,176.8	5.01%
Tianjin	1,016.66	73,839	75,069,157.74	8.07%
Jinan	621.61	62,323	38,740,600.03	4.16%
Harbin	987.29	51,554	50,898,748.66	5.47%
Ningbo	583.78	70,228	40,997,701.84	4.41%
Guangzhou	842.42	42,955	36,186,151.1	3.89%
Total			930,518,152.4	100.00%

[5] Air transport distances are compiled from http://www.gcmap.com/; marine transport distances between ports are compiled from http://www.sea-distances.org/; we do not have detailed road distances between cities, so that the great circle distances are compiled from https://www.distancecalculator.net/, which are also used to validate the air travel distances if such data are unavailable from the first website.

3.3. The application of the model and data sources

The information set forth in the preceding table is applied to the top 10 points of origin for imports, so that the full OD demand matrix can be obtained. With the OD matrix and cost-minimization model specified in Section 3.1, the most economical routes between any OD pair can be obtained. Due to space limitations, the following table reports only a few randomly selected routes.

Table 7. Modeling Results for Randomly Selected OD Pairs

Origin	Destination	Gateway	Origin-Gateway Mode	Gateway-Destination Mode	Generalized Cost
Marseille	Shanghai	Shanghai	Sea	None	19,082,238
Marseille	Beijing	Tianjin	Sea	Road	21,016,236
Marseille	Chengdu	Guangzhou	Sea	Air	15,617,410
Marseille	Hangzhou	Shanghai	Sea	Road	7,535,530
Marseille	Taiyuan	Tianjin	Sea	Air	4,005,096
Barcelona	Wenzhou	Shanghai	Sea	Road	1,906,062
Barcelona	Chengdu	Guangzhou	Sea	Air	5,140,038
Venice	Wenzhou	Shanghai	Sea	Road	773,508
Venice	Chengdu	Guangzhou	Sea	Air	2,092,781
Cape Town	Shanghai	Shanghai	Sea	None	938,744
Cape Town	Beijing	Tianjin	Sea	Road	1,050,992
Auckland	Wenzhou	Shanghai	Sea	Road	45,403
Auckland	Chengdu	Guangzhou	Sea	Air	138,618
Auckland	Hangzhou	Shanghai	Sea	Road	55,325
Auckland	Taiyuan	Tianjin	Sea	Air	31,888

With the detailed mode choices and cost information calculated for each OD pair, it can be seen that for wine imported from overseas to the gateways, only maritime shipping is used. Such a pattern is actually different from reality, as a very small percentage of wines are delivered by air. Air transport is much costlier than marine shipping. Thus, it is used only for very expensive, fine wines. However, the values of time we use in the calculation are quite low. Our model can be improved to incorporate such a market reality if the detailed price and volume data become available for fine wines, which will be a meaningful extension to this study. For wine distribution within mainland China, the transport mode shares of air, road and marine/water transport are 25.4%, 32.4%, and 17.4%, respectively. About 24.8% of wine imports are consumed at gateway cities and thus do not require any further domestic transport. Such results suggest that although air cargo is too expensive for long-distance intercontinental imports, it can be an economical distribution method domestically. We modify the time for customs clearance. Although it may have some effect on the choice of gateways, it has no substantial effect on the selection of transport modes.

Note that our model considers only the actual shipping and time costs associated with delivery from the imported wine's point of origin to the destination Chinese cities. In practice, wine imports also involve a substantial number of support services for such things as import license applications, quality controls, repacking, labeling, and inspection. Therefore, many companies choose to consolidate their imports at selected gateways to achieve economies of scale. To identify the most promising gateway where companies can locate their wine distribution centers, we calculate the total costs for each gateway in hypothetical cases in which all wine imports into China must pass through one gateway only. The corresponding total costs are summarized as follows

Table 8. Rank of Gateway Cities by Efficiency

Efficiency Rank	Gateway	Total Costs
4	Hong Kong	388,359,947
5	Beijing	847,099,083
1	Shanghai	352,355,165
2	Tianjin	353,457,517
3	Guangzhou	386,594,755
6	Chongqing	918,022,125

Such a calculation suggests that if a wine distributor plans to establish a wine distribution center for wine imports to China, the most preferred gateways are Shanghai, Tianjin, Guangzhou, and Hong Kong, which have similar delivery costs. In comparison, Beijing and Chongqing have much higher delivery costs, mainly because they lack good access to marine transport and/or an efficient domestic distribution network. Of course, our analysis considers only logistics-related costs for the current OD consumption pattern. If we also consider other valued-added services such as license applications, documentation, relabeling, and quality control, there may be some change in the rankings. For example, due to Hong Kong's status as a premium service and trade hub, it has a growing market share of China's wine imports.

4. Conclusion

The trade and logistics operations of wine involve some special requirements for handling, storage, and transport, and many value-added services such as license applications, documentation, quality control and relabeling. It is often economical for wine importers to consolidate their logistics services in one city to achieve economies of scale for logistics and trade-related activities. The sustained growth of Chinese wine imports provides excellent business opportunities for marine shippers and logistics providers. The OBOR initiative achieves policy coordination, transport connectivity, unimpeded trade, financial integration, and people-to-people bonds. However, commodity trading between Europe and Asia is quite imbalanced, with more cargo being exported from Asia to Europe than the other way around. Such an imbalance not only leads to asymmetric cargo flow and the underuse of backhaul transport, but also raises political concerns and trade disputes between countries, especially in China. Therefore, there is a two-way positive relationship between the OBOR initiative and wine logistics services for China. On the one hand, the OBOR initiative is expected to facilitate trade between the countries in the region, together with business activities related to wine products. On the other hand, the growth of Chinese wine imports also helps China balance its trade with other countries, especially the wine producers of Europe. Furthermore, it provides the maritime sector with an excellent growth opportunity.

In this study, we review the special requirements of wine logistics and the market growth potential for wine consumption in China. A model minimizing generalized logistics costs is developed and applied to Chinese wine imports, so that the best candidate cities in which to locate transport gateways and distribution centers can be identified. Our analysis suggests that the most preferred gateways are Shanghai, Tianjin, Guangzhou, and Hong Kong, which have similar delivery costs. In comparison, Beijing and Chongqing have much higher delivery costs, mainly because they do not have good access to marine transport and/or efficient domestic distribution networks. For long distance intercontinental transport, marine shipping remains the only viable delivery mode for large-volume wine trade. However, wine distribution within China extensively uses air, road, and water transport. Therefore, cities with excellent multi-modal transport services are better positioned to become wine logistics gateways.

The wine industry is an important economic driver of international trade and logistics services. Our study provides some useful insight into this sector in particular and the OBOR initiative in general. However, it should be noted that our analysis considers only logistics-related costs for the current OD consumption pattern. Other valued-added services, such as license applications, documentation, relabeling and quality control must also be considered in a company's location choice of distribution centers. We hope this study leads to more comprehensive studies on this burgeoning topic using advanced investigation methods.

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